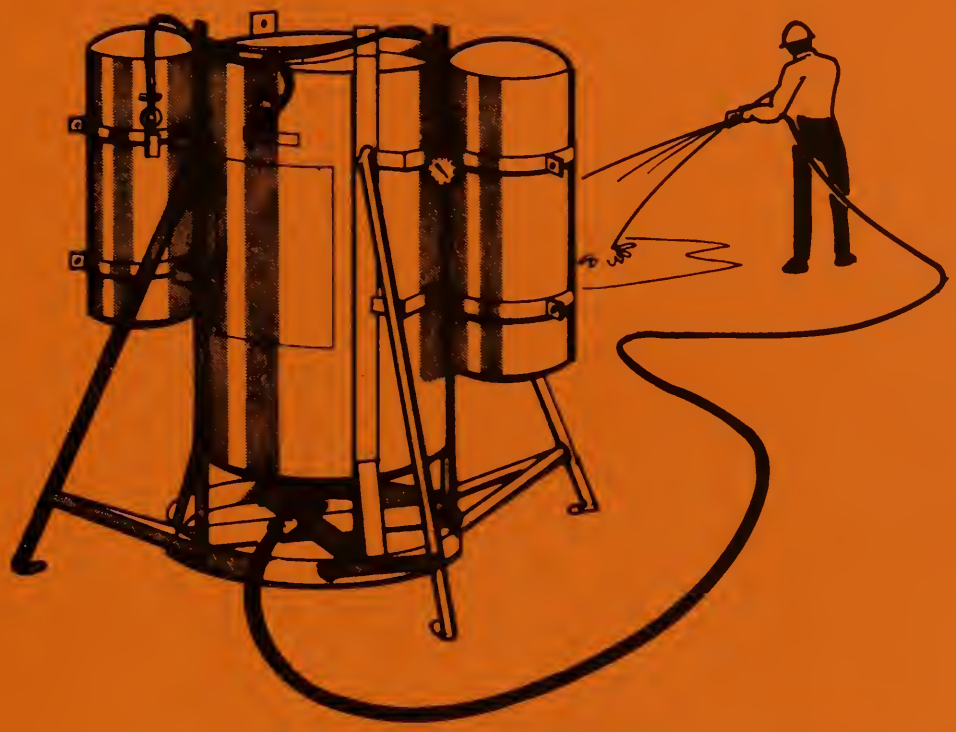
project record

helicopter DUST ABATEMENT *system*



ED&T 2528
EVALUATE CHEMICALS FOR DUSTPROOFING HELISPOTS

JUNE 1977

USDA ■ Forest Service Equipment Development Center ■ Missoula, Montana

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PROJECT RECORD

HELICOPTER DUST ABATEMENT SYSTEM

ED&T 2528

EVALUATE CHEMICALS FOR DUSTPROOFING HELISPOTS

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ABSTRACT

The Forest Service Equipment Development Center at Missoula, Mont. (MEDC), evaluated dust abatement chemicals and developed a spray system for applying them on helispots. Based on work by the Corps of Engineers Waterways Experiment Station and MEDC testing, DCA-1295, a polyvinyl acetate (PVA) emulsion, was recommended for dustproofing helispots. Another PVA emulsion, Vynsol®, was considered an acceptable substitute. Testing indicated that for Forest Service use, pumping a 2:1 solution of PVA emulsion and water at 3.3 pounds per square yard forms an adequate dustproofing film. An applicator transported by small helicopter was developed and evaluated.

A report on Equipment Development and Test Project 2528--Evaluate Chemicals for Dustproofing Helispots, funded by the Aviation Management Staff.

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INTRODUCTION

The Forest Service uses helicopters extensively in fire control and other projects. At helicopter landing spots (helispots) dust abatement is necessary, not only to keep pilot vision unimpaired, but also to reduce engine contamination, airframe damage, blade erosion, and danger to ground personnel.

Because dust control in helicopter operations is a continuing problem, the Equipment Development Center at Missoula (MEDC) drafted a project proposal, Equipment Development and Test (ED&T) 2528--Evaluate Chemicals for Dustproofing Helispots, in March 1974. Our objective was to evaluate dust abatement chemicals and develop a simple spray system for applying them on helispots. Our specific requirements for a dustproofing chemical were:

- Must provide adequate dustproofing on dry, bare soils and on grass and typical forest floor litter.

- Must be easy to apply with conventional powered and backpack spray equipment.

- Must not corrode helicopter components in any way nor be toxic to humans or animals.

- Must not add to the fire hazard of the natural ground cover and preferably should reduce the hazard.

- Must not be slippery or sticky after a rain or heavy dew.

- Must be durable and require little maintenance or retreatment after heavy use. Treatment should last a full field season.

- Should be less than 3 cents a square foot of treated area.

The need for development work in dust abatement was reinforced by two separate interagency groups whose objectives were to improve safety in helicopter operations. One, appointed in 1972 by Forest Service Chief John McGuire to study problems and recommend solutions to helicopter operations safety, recommended in its 1974 National Helicopter Operations Study: "Develop and implement a dust abatement program of heliports and helispots. Use the best dust palliative available." A second interagency group, the National Helicopter Equipment Workshop, in June 1974 discussed the dust control problem and recommended that ED&T 2528 be funded to evaluate chemicals for dustproofing helispots.

INVESTIGATION

The Corps of Engineers Waterways Experiment Station (WES) at Vicksburg, Miss., has been working on dust control agents for military use since 1966. So early in our project we sent two Center representatives there to learn more about this work. WES during its investigation evaluated more than 300 materials in laboratory and field tests.[1/] Of these, DCA-1295, a polyvinyl acetate (PVA) emulsion from Union Carbide was selected as having the greatest potential for meeting military dust abatement needs. Soil stabilization specialists at WES recommended it for Forest Service use because it is easier to apply and has a longer service life than other materials tested. It is not toxic to animals or plants and will not burn. In fact, since it covers so completely, it reduces the chance of fire starts in ground cover.

At the time WES personnel made their recommendation to us, they were unsure how available DCA-1295 was and advised us that another PVA emulsion, Vynsol[R], a product of Environmental Stabilization Engineering, Inc., would be a reasonable substitute.

WES tested application rates of 3, 5, and 7 pounds per square yard at three parts DCA-1295 to one part water. Since the Army uses much larger and more powerful helicopters than the Forest Service, we elected to run field tests to determine application rates and dilution ratios most suitable for Forest Service needs. WES personnel recommended we try both DCA-1295 and Vynsol at dilution rates of three parts of polyvinyl acetate to one part water and application rates of 3 and 5 pounds per square yard.

Diluting PVA emulsion with water simplifies handling and application, but the dilution rate has little effect on the film produced. For this reason, and because transporting large quantities of water to remote sites can be difficult and expensive, we elected to test PVA emulsions using minimum dilution rates:

- One part PVA emulsion to one part water (1:1).

- Two parts PVA emulsion to one part water (2:1).

- Concentrated PVA emulsion (no water added)

FIELD TESTS

We conducted field tests at helispots on the Los Padres National Forest, Calif. We wanted to determine: (1) the most durable and economic film thickness; (2) the most practical application method for distributing the material evenly over the helispot; (3) the minimum water necessary to dilute the material for application. Details of the field tests can be found in appendixes A and B.

Personnel on the Los Prietos Ranger District selected three helispots for the tests. We tested two types of polyvinyl acetate emulsions: approximately 100 gallons of DCA-1295, and 55 gallons of Vynsol Class I, Type B, and 55 gallons of Vynsol Class I, Type C.

Film Thickness Control

PVA is a film former not a soil binder, so thickness (as determined by the application rate) is critical to the film's durability. The dilute solution must be distributed uniformly over the helispot to insure durability. The manner in which the application equipment distributes the solution is more important than the equipment used.

1/ C. R. Styron, III, discusses the method of selecting a dust control material in the November 1975 issue of Engineering and Scientific Research at WES.

Application Methods

We determined application rates by the ratio of test area-to-applied chemical. We tested three application methods: (1) spreading from a lawn fertilizer spreader; (2) spraying under pressure from a Homelite portable pump through a 5-foot-long, 1-inch diameter spray bar with 14 (1.5 gallons per minute) spray nozzles; and (3) squirting under pressure from Homelite portable pump through an open-ended hose with a stream formed by placing the thumb over the hose end. (An open-end hose avoided problems with plugging and cleaning a hose nozzle.)

Discussion

Our field tests indicated that thin films showed a tendency to crack and break up more easily than thick films. The thickest uniform film developed (0.10 inch) was applied at 6.7 pounds of concentrate per square yard with the fertilizer spreader, a practical applicator only on smooth, level ground. The second thickest uniform film was developed by pumping a 2:1 solution through a hose and squirting it at 3.3 pounds per square yard. This method was most suited to Forest Service use. Using DCA-1295 in 2:1 solution at an application rate of 3.3 pounds per square yard, we estimated it would take $163.56 worth of PVA emulsion to dustproof a 40-foot diameter helispot. See table 1 for cost figures on larger helispots

Table 1.--Dust coating requirement chart

Helispot diameter (ft)	Area sq ft	Area sq yd	DCA-1295 Polyvinyl acetate required at 3.3 lb/sq yd (gal)	Dilution ratio 2:1*	Total mixture (gal)	Cost**
40	1,256	140	47	24	71	$163.56
45	1,590	177	59	30	89	205.32
50	1,962	218	73	37	100	254.04
55	2,375	264	88	44	132	306.24
60	2,826	314	105	53	158	365.40
65	3,317	369	123	64	187	428.04
70	3,847	427	142	71	213	494.16
75	4,416	491	164	82	246	570.72
80	5,024	558	186	93	279	647.28
85	5,672	630	210	105	315	730.80
90	6,359	707	236	118	354	821.28

* Two parts DCA-1295 to 1 part water.

** Costs for DCA-1295 figured at $3.48 a gallon based on April 1976 prices for 1 to 2 drums.

LABORATORY TESTS

To determine if the PVA emulsion would last a full field season, we subjected it to accelerated weathering tests. Samples of Vynsol were mixed in various diluted solutions on sample plate holders and air-cured to form a film of desired thickness. (At the time of laboratory testing, DCA-1295 was not available.)

The Center's ATLAS Model XW-R weatherometer, an accelerated weathering chamber with an exposure ratio of 300 machine hours to 1 year, was used for the test. This weatherometer simulates the effects of sunlight and moisture. Each sample was subjected to 150 hours of testing, equal to 6 months of exposure to sunlight and moisture. The Vynsol samples showed no sign of degradation.

APPLICATOR EQUIPMENT

Criteria established for the development of the dust abatement applicator came from tests conducted on the Los Padres National Forest, Forest personnel, other field users, and WES experience.

During our field tests of PVA emulsions, we learned that Forest personnel had a preliminary design of a pressurized applicator. Based on that design, we developed a system employing two separate air tanks attached to the tank holding the PVA solution; compressed air dispenses the PVA. An air compressor capable of filling each air tank to a minimum of 70 pound-force per square inch gravity (psig) provides the compressed air. Improvements were made, and the system has been assembled for field testing (fig. 1).

Figure 1.--Helicopter dust abatement applicator.

We selected applicator components from commercial pressure vessels and standard parts, enabling it to be constructed in many areas of the country. It was designed to be sling-carried by helicopter and placed on the ground without landing the aircraft or tipping over the tank. One person can operate and refill the system. The design allows easy flushing, and controls and fittings are located for their maximum protection. Another consideration was applicator size and weight. The Bell 47 G3B series helicopter was selected as the smallest practical helicopter to carry the fully charged applicator.

The helicopter dust abatement system has a capacity of 42 gallons and an empty weight of 184 pounds; it weighs 554 pounds loaded. It requires one air tank, pressurized to 70 psig, to dispense all the solution under pressure, beginning at 70 psig and decreasing to approximately 10 psig when empty. If more than 42 gallons of solution is required, the solution tank can be refilled at the helispot site and the second air tank used to dispense the solution. If more refillings are necessary, provisions must be made for recharging air tanks. It is necessary to flush the entire system thoroughly with water to avoid clogging it with hardened material. Methyl ethyl ketone or acetone will break down cured PVA emulsion.

To dispense the PVA, after filling and pressurizing the system, the operator simply turns a valve on and places his thumb over the end of the hose and squirts the solution on the ground as desired. Instructions are printed on the tank and a field-use instruction card is provided (appendix C).

Because the applicator equipment was designed for the Bell 47 G3B series helicopter, it was limited in size and weight. When treating a very small helispot, the applicator may have the capacity to complete the job without refilling the air tanks. The applicator is ferried to the helispot and placed on the site to be treated. The charged applicator is emptied of its solution by one of the air tanks. The crew on the helispot then refills the liquid tank and dispenses the PVA solution by changing the selector to the other air tank. The helispot is treated without requiring the helicopter to ferry the tank away to be filled. If the helicopter is a smaller one, the PVA solution for refilling must be ferried to the site. With larger helicopters, such as the Bell 205, extra PVA solution might be carried on board and the applicator carried in a sling. This delivers the applicator and the solution in one trip, cutting helicopter costs.

Another method that may have some merit is charging extra air tanks that can be switched with those attached to the applicator. When applicator, solution, and air tanks are delivered in one trip the entire operation of treating the helispot can be completed without replenishing components from the base helispot. This method also reduces helicopter operating cost.

Conditions vary with the type of helicopter used to ferry equipment and the helispot itself. At present, DCA-1295 can be ordered only in 55-gallon drums weighing over 500 pounds each; Vynsol can be purchased in 5-gallon plastic containers.

Polyvinyl acetate should be stored at normal warehouse temperature, 50° F to 80° F. Partially used vessels should be sealed airtight to prevent curing.

The helicopter dust abatement system--applicator, hose, sling, and air compressor--should be stored as a unit.

PRELIMINARY EVALUATION

In March 1976 we demonstrated the helicopter dust abatement system to a California Region helicopter foreman training session in Fresno. We then gave more specific instruction to Los Padres National Forest personnel where the system is assigned for field evaluation.

Helicopter operations personnel at Fresno and on the Los Prietos Ranger District of the Los Padres Forest have recommended these improvements:

- Protect top selector valve and air valves better.

- Lighten system.

- Include portable air compressor as part of system.

- Enlarge liquid fill plug to 2-inch or 3-inch diameter and mount stir stick on side of tank.

- Design handle of liquid fill plug so greater leverage may be applied to it.

CONCLUSIONS

The system we designed meets the specific requirements listed in the introduction, except that the system employs a large tank carried by sling from a helicopter rather than a conventional backpack spray equipment and cost of the PVA is greater than 3 cents a square foot of treated area.

The project identified two polyvinyl acetate emulsions that are suitable for dust abatement on helicopter landing sites. Union Carbide's DCA-1295 was specifically formulated for use on helicopter and aircraft landing sites. According to WES, it is easier to apply and has better service life than other PVA emulsions tested. Environmental stabilization Engineering, Inc.'s Vynsol Class I, Types B and C also met the established requirements.

Union Carbide's DCA-1295 prices for 55-gallon drums in April 1976 were:

1-2 drums: $3.48 a gallon
3-9 drums: $3.19 a gallon
10-39 drums: $3.04 a gallon

Direct orders for DCA-1295 to:

Union Carbide Co.
Chemical Plastics Division
1 University Plaza
Hackensack, N.J. 07601

Environmental Stabilization Engineering, Inc.'s Vynsol prices for Types IB and IC were:

5-gallon plastic containers: $6 a gallon

55-gallon drums (1 to 8 drums): $5 a gallon

55-gallon drums (9+ drums): $4.50 a gallon

Orders for Vynsol should be directed to:

Environmental Stabilization Engineering, Inc.
9050 Telegraph Rd.
Downey, Calif. 90240
Phone: 213-868-3251

Our tests indicated that for Forest Service use, pumping 2:1 solution of PVA emulsion and water through an open-ended hose and squirting it by hand at 3.3 pounds per square yard is best.

MEDC drawings for the dust abatement system prototype are being prepared. Based on preliminary evaluation by California Region personnel some changes in the system are needed.

RECOMMENDATIONS

1. Union Carbide's DCA-1295 should be used for helispot dust abatement. Environmental Stabilization Engineering, Inc.'s Vynsol Class I Type B or Type C should be used as a substitute.

2. Application of PVA emulsions should be accomplished with the helicopter dust abatement system at two parts PVA to one part water; 3.3 pounds of concentrate per square yard provides adequate film thickness.

3. MEDC should make design changes of its dust abatement system based on the California Region's preliminary findings, and complete drawings.

4. MEDC should continue to follow up on the Los Padres National Forest evaluation and redesign and improve as needed.

FIELD TEST RESULTS

TEST RESULTS

Test Plot 1 (fig. 2)

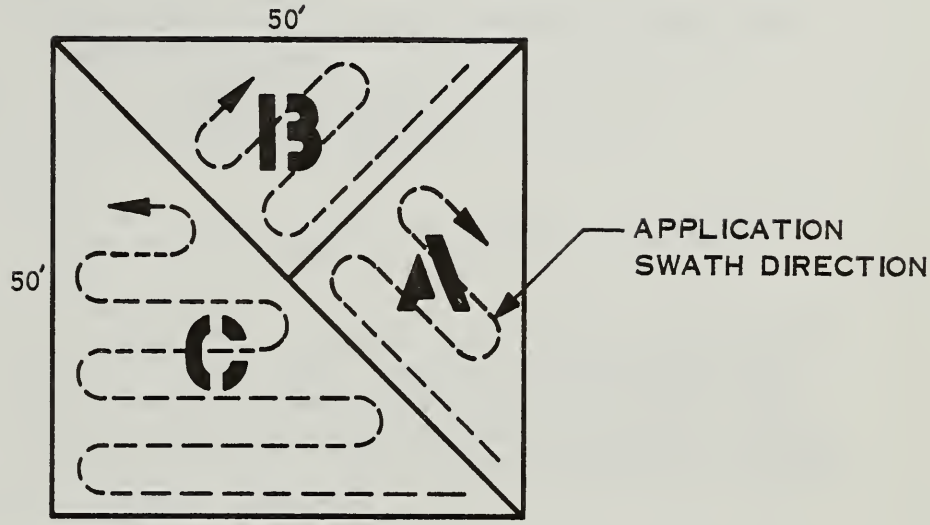


Figure 2.--Test Plot 1

Plot 1-A

Material - DCA-1295
Area - 625 sq ft or 69 sq yd
Dilution - none
Application method - fertilizer spreader
Amount applied - seventeen 3-gal containers = 51 gal
Application rate - 51 gal x 9 lb/gal/69 sq yd = 6.7 lb/sq yd
Cost - $165.24 (0.2644 $/sq ft or 2.38/sq yd)
Cure time - approximately 18 to 24 hours for complete film cure
Film thickness - 0.10 inch
Penetration - not as penetrating as water-diluted material, causing a poor bond
Surface - graded and flat
Soil moisture - dry, no prewetting
Comments: The chemical was applied as a uniform film the width of the fertilizer spreader. With wind calm, the film remained intact as it left the spreader. But under strong gusty winds it broke up, resulting in an unsatisfactory, spotty ground coating. The ground under the wheels of the spreader was untreated because the wheels, which extended beyond the width of the spreader box, were run beside rather than in the previously placed strip. Spreading is a satisfactory application method of concentrated materials for flat, even surfaces.

Plot 1-B

Material - DCA-1295
Area - 625 sq ft or 69 sq yd
Dilution - 1 part DCA-1295:1 part water
Application method - 5-foot-long spray bar with fourteen 1.5 gpm spray nozzles; Homelite centrifugal pump
Amount applied - four 3-gal containers = 12 gal
Application rate - 12 gal x 9 lb/gal/69 sq yd = 1.6 lb/sq yd
Cost - $38.88 (0.0622 $/sq ft or 0.56 $/sq yd)
Cure time - 2 to 4 hours
Film thickness - 0.025 inch
Penetration - deeper than undiluted material, providing a good bond
Surface - graded and flat
Soil moisture - dry, no prewetting
Comments: The purpose of using the spray bar was to control film thickness by controlling flow rate. Because of the consistency of the solution and the irregularities of the surface, the solution drained into puddles and thickness could not be controlled. The spray nozzles clogged with particles of solution and required frequent cleaning.

Plot 1-C

Material - DCA-1295
Area - 1,250 sq ft or 138 sq yd
Dilution - 1 part DCA-1295:1 part water
Application method - fertilizer spreader
Amount applied - 37 gal
Application rate - 37 gal x 9 lb/gal/138 sq yd = 2.4 lb/sq yd
Cost $119.88 (0.0959 $/sq ft or 0.86 $/sq yd)
Cure time - approximately 2 to 4 hours
Film thickness - unable to determine (see Comments)
Penetration - deeper than undiluted material; provided a good bond
Surface - graded and flat
Soil moisture - dry, no prewetting
Comments: Film thickness control was lost because solution drained into puddles in addition to the rapid flow rate out of the spreader.

Plot 2 (fig. 3)

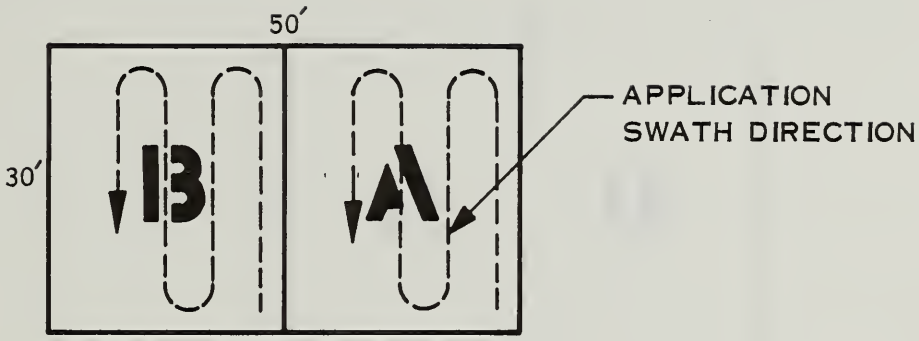


Figure 3.--Test Plot 2.

Plot 2-A

Material - Vynsol Class I, Type C
Area - 750 sq ft or 83 sq yd
Dilution - 2 parts Vynsol:1 part water
Application method - fertilizer spreader
Amount applied - twelve 3-gal containers = 36 gal
Application rate - 36 gal x 9 lb/gal/83 sq yd = 3.9 lb/sq yd
Cost - $180 (0.2400 $/sq ft or 2.16 $/sq yd)
Cure time - 2 to 4 hours
Film thickness - unable to determine
Penetration - deeper than undiluted material; provided a good bond
Surface - graded and flat
Soil moisture - dry, no prewetting
Comments: Film thickness control was lost

Plot 2-B

Material - Vynsol Class I, Type B
Area - 750 sq ft or 83 sq yd
Dilution - 1 part Vynsol:1 part water
Application method - fertilizer spreader
Applied amount - three 3-gal containers = 24 gal
Application rate - 24 gal x 9 lb/gal/83 sq yd = 2.6 lb/sq yd
Cost - $120 (0.1600 $/sq ft or 1.44 $/sq yd)
Cure time - 2 to 4 hours
Penetration - deeper than undiluted material; provided a good bond
Surface - graded and flat
Soil moisture - dry, no prewetting
Comments: Material foamed or bubbled after being placed on the ground. Also film separation occurred on the ground.

Plot 3 (fig. 4)

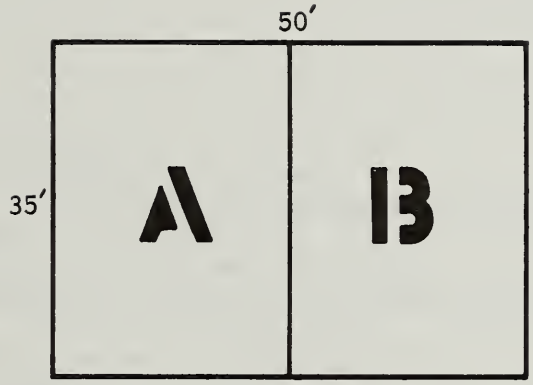


Figure 4.--Test Plot 3.

Plot 3-A

Material - Vynsol Class I, Type B and C
Area - 875 sq ft or 97 sq yd
Dilution - 2 parts Vynsol: 1 part water
Application method - squirting from open-end hose through Homelite centrifugal portable pump
Amount applied - 19 gal Type C; 17 gal Type B
Application rate - 36 gal x 9 lb/gal/97 sq yd = 3.3 lb/sq yd
Cost - $180 (0.2057 $/sq ft or 1.85 $/sq yd)
Cure time - 2 to 4 hours
Film thickness - not measured
Penetration - deeper than undiluted material, providing a good bond.
Surface - graded and flat
Soil moisture - dry, no prewetting
Comments: This plot was to be divided into two equal areas, each to be treated with equal amounts of Type B and Type C diluted 2 parts emulsion to 1 part water. Control was lost when a treatment with Type C material overlapped onto the Type B treatment area.

This method of application is suitable for building up thick films of material without the associated problem of puddling or running solution. Problems were encountered in the pumping system when particles of cured material lodged in the outlet of the solution tank causing slow flow rates. Particles had to be dislodged with a stick to restore flow. Recirculating the solution through the centrifugal pump back into the solution tank causes foaming. This did not seem to cause any serious problems with pumping or spreading the material.

Plot 3-B

Material - DCA-1295
Area - 875 sq ft or 97 sq yd
Dilution - 2 parts DCA-1295:1 part water
Application method - squirting from open-end hose through Homelite centrifugal pump
Amount applied - six 3-gal containers = 18 gal
Application rate - mechanical failure resulted in rate undetermined (see Comments)
Cost - $58.32 (0.0667 $/sq ft or 0.60 $/sq yd)
Cure time - 2 to 4 hours
Film thickness - mechanical failure resulted in highly variable thicknesses
Penetration - deeper than undiluted material, providing a good bond
Surface - graded and flat
Soil moisture - dry, no prewetting
Comments: The plot was treated by this method until the starting rope separated from the recoil starter mechanism and the remainder "ran out" on the ground. As a result, film thickness control was lost. This application method allowed building up film thickness without puddling or running solution.

Test Results for Dustproofing Helispots with Polyvinyl Acetate Emulsions

Plot No.	Plot area sq yd	Material	Dilution ratio, material to H_2O	Application method	Amount material applied gallons	Application rate (lb/sq yd)	Cost material only ($/sq yd)	Cure time (hours)	Film[1] thickness (inches)	Performance observations: Spreading[2] Good	Spreading[2] Poor	Pumping[3] Good	Pumping[3] Poor	Uniformity of film[4] Good	Uniformity of film[4] Poor	Bond to soil[5] Good	Bond to soil[5] Poor	Durability (wear)[6] Good	Durability (wear)[6] Poor	Handling qualities[7] 55 gal drum Good	Handling qualities[7] 55 gal drum Poor	Handling qualities[7] 5 gal drum Good	Handling qualities[7] 5 gal drum Poor	Consistency[8] Thick	Consistency[8] Milky	Consistency[8] Watery	Cure[9] time Rapid	Cure[9] time Slow	Film[10] thickness control Good	Film[10] thickness control Poor
1-A	69	DCA-1295	--	Spread	51	6.7	2.38	18-24	0.10	x		---NA----		x			x				x			x					x	
1-B	69	DCA-1295	1:1	Sprayed	12	1.6	.56	2-4	.025	----NA----		x				x					x					x	x			x
1-C	138	DCA-1295	1:1	Spread	37	2.4	.86	2-4			x	---NA----			x	x					x					x				x
	Total 276				Total 100													NOT AVAILABLE				NOT AVAILABLE								
2-A	83	Vynsol, Class 1, Type C	2:1	Spread	36	3.9	2.16	2-4	NOT AVAILABLE		x	---NA----			x	x					x				x					x
2-B	83	Vynsol, Class 1, Type C	1:1	Spread	24	2.6	1.44	2-4			x	---NA----			x	x					x					x				x
	Total 166				Total 60																									
3-A	97	Vynsol, Class 1, Type B&C	2:1	Squirted	36	Undetermined (3.3) approx	1.85	2-4		----NA----		x		x		x					x				x		x		x	
3-B	97	DCA-1295	2:1	Squirted	18	Undetermined (1.6) approx	0.60	2-4		----NA----		x		x		x					x					x	x		x	
	Total 194				Total 54																									

1 Film thicknesses were not measured because films were not uniform or fully cured.

2 Observations apply to relatively smooth flat surfaces.

3 Pumping characteristics were considered good if the material could be pumped through an open-ended hose and squirted on the ground.

4 Film thicknesses were not uniform because of puddling and running of the solution and were considered poor.

5 Penetration was slight for concentrated material and deeper for diluted solutions.

6 No tests were conducted with helicopters but scuffing by one's shoes indicated good film toughness properties for all tests. Test samples indicated the thinner films are more easily broken up.

7 5-gallon containers were not available at the time of testing -- 55-gallon drums would be extremely difficult to handle (both physically and for preparing the solution).

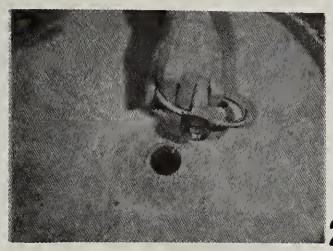
8 Consistency of 2:1 solutions were easily prepared and applied.

9 The concentrated or puddled solutions required more time to cure than the sprayed or squirted on solutions. Curing begins immediately after exposure to air, whether in containers or on ground.

10 The surfaces treated were graded and flat surfaces, although the method of "squirting on" the solution wou[illegible] equally well for irregular surface because successive layers can be built up as desired for film thickness.

INSTRUCTIONS
HELISPOT DUST CONTROL SYSTEM


1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3


4

To Charge

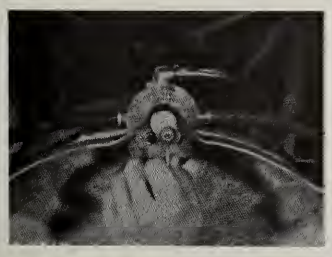
1. Close ON-OFF liquid valve located near bottom of tank.
2. Open top fill plug.
3. Disconnect air line at coupler located near air tank.
4. Position 3-way air valve to uncoupled air hose for air bleed.
5. Put 14 gallons of water in tank.
6. Add 28 gallons of polyvinyl acetate.
7. Replace fill plug and tighten.
8. Replace air hose.
9. Position 3-way air valve to OFF position.
10. Fill air tanks to indicated pressure range (70-75 PSIG).


7


8


9


10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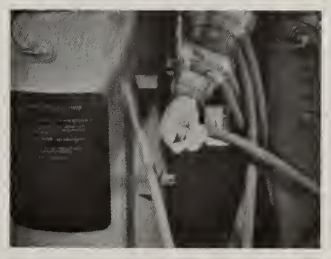
3

To Dispense

1. Uncoil hose.
2. Position 3-way air valve to desired air tank.
3. Depress tank air valve to ON position.
4. Open ON-OFF liquid valve.
5. Form desired spray pattern by placing thumb over hose end.


4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Caution *Polyvinyl acetate forms a solid when exposed to air. To prevent clogging of the tank, drain completely and rinse with clean water as soon as possible after using.*